Executing Models: Enhancing Validation by Filmstrip Templates and Transformation Alternatives

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EXE 2017, Austin
Outline

» Introduction
» Approach to Behavior Modeling: Filmstripping
» Motivation
» Overview on Validation Process
» Architectures for Filmstripping
» Filmstrip Templates
» Study Execution
» Study Results and Comparison
» Conclusion and Future Work
Introduction

» Model analysis and property validation and verification crucial for success of MDE

» USE model validator:
  » Automatic test case construction
  » Model validation and consistency check
  » Analysis of structural properties

» Application models involve structural and dynamic aspects

» Filmstripping is used for validation of dynamic aspects
Filmstripping

» Filmstripping transforms pre- and postconditions to invariants

» Filmstrip model has only structural aspects

» Dynamic and structural aspects of a UML/OCL model can be explored using filmstripping
Filmstripping
Motivation

* ANALYZING THE IMPACT OF DIFFERENT ARCHITECTURES AND FILMSTRIP TEMPLATES ON EXECUTION TIME OF VALIDATION PROCESS
Overview on Validation Process

1. **USE filmstripping**
   - application model
   - filmstrip model
   - filmstrip template
   - partial object diagram
   - USE model validator
   - complete object diagram

2. **External invariants**
   - (for specific scenario)

3. **Configuration**
   - application model elements
   - filmstrip model elements

4. **Different filmstrip architectures**
Architectures for Filmstripping

(A) Ternary association [short: Tern Assoc]

(B) OpCall at Snapshot + Association [short: C@Snap Assoc]

(C) OpCall at Snapshot + Aggregation [short: C@Snap Agg]

(D) OpCall at Snapshot + Composition [short: C@Snap Comp]

(E) Snapshot OpCall Snapshot as Association [short:SnapCSnap Assoc]

(F) Snapshot OpCall Snapshot as Aggregation [short: SnapCSnap Agg]

(G) Snapshot OpCall Snapshot as Composition [short: SnapCSnap Comp]
Filmstrip Templates

» Templates consist of the elements which are known from the filmstrip model and given configurations.

» Filmstrip template is constructed before the model validation.

» Templates of architecture B, C and D have extra snapshot-snaphot links compared to all other architectures.
Study Execution

» Check the performance of different architectures with filmstrip templates

» 2 models selected:
  » Library model
  » ConcurrentAppend model

» Two test case scenarios are considered for the study

» Each test case is executed five times and trimming mean method has been used for average calculation
## Study Execution

<table>
<thead>
<tr>
<th></th>
<th><strong>Test case 1</strong></th>
<th><strong>Test case 2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Library model</strong></td>
<td><strong>ConcurrentAppend model</strong></td>
</tr>
<tr>
<td><strong>Application configuration</strong></td>
<td>1 User, 1 Book, 1 Copy</td>
<td>3 Cells, 1 Append</td>
</tr>
<tr>
<td><strong>Invariants</strong></td>
<td><strong>Initial condition:</strong> Copy is in library and number of returns is zero. <strong>Final condition:</strong> Number of returns of the copy is three.</td>
<td><strong>Initial condition:</strong> Mention three Cells and one Append with values. <strong>Final condition:</strong> Append should be finished.</td>
</tr>
<tr>
<td><strong>Filmstrip configuration</strong></td>
<td>Snapshot = 7..7 borrow_UserOpC = 0..6 return_UserOpC = 0..6 borrow_CopypOpC = 0..6 return_CopypOpC = 0..6</td>
<td>Snapshot = 5..5 append_AppendOpC = 0..4 return_AppendOpC = 0..4 found_AppendOpC = 0..4 next_AppendOpC = 0..4</td>
</tr>
<tr>
<td><strong>Expected Results</strong></td>
<td>3 Borrow-Return operation calls.</td>
<td>Next-Next-Append-Return operation calls.</td>
</tr>
</tbody>
</table>
## Study Results and Comparison

» Result comparison - test case 1

<table>
<thead>
<tr>
<th>Architecture</th>
<th>A Tern Assoc (min)</th>
<th>B C@Snap Assoc (min)</th>
<th>C C@Snap Agg (min)</th>
<th>D C@Snap Comp (min)</th>
<th>E SnapCSnap Assoc (min)</th>
<th>F SnapCSnap Agg (min)</th>
<th>G SnapCSnap Comp (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test case 1</td>
<td>32.73</td>
<td>0.43</td>
<td>1.34</td>
<td>1.41</td>
<td>2.50</td>
<td>3.23</td>
<td>3.28</td>
</tr>
<tr>
<td></td>
<td>0.13</td>
<td>0.07</td>
<td>0.09</td>
<td>0.08</td>
<td>0.15</td>
<td>0.16</td>
<td>0.16</td>
</tr>
</tbody>
</table>

» Result comparison - test case 2

<table>
<thead>
<tr>
<th>Architecture</th>
<th>A Tern Assoc (min)</th>
<th>B C@Snap Assoc (min)</th>
<th>C C@Snap Agg (min)</th>
<th>D C@Snap Comp (min)</th>
<th>E SnapCSnap Assoc (min)</th>
<th>F SnapCSnap Agg (min)</th>
<th>G SnapCSnap Comp (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test case 2</td>
<td>90.47</td>
<td>29.13</td>
<td>20.00</td>
<td>20.46</td>
<td>20.15</td>
<td>29.24</td>
<td>27.90</td>
</tr>
<tr>
<td></td>
<td>0.33</td>
<td>0.21</td>
<td>0.22</td>
<td>0.23</td>
<td>0.25</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td>Architecture</td>
<td>A Tern Assoc (min)</td>
<td>B C@Snap Assoc (min)</td>
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<td>E SnapCSnap Assoc (min)</td>
<td>F SnapCSnap Agg (min)</td>
<td>G SnapCSnap Comp (min)</td>
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<td>-----------------------</td>
</tr>
<tr>
<td>Test case 1</td>
<td>0.13</td>
<td>0.07</td>
<td>0.09</td>
<td>0.08</td>
<td>0.15</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>Test case 2</td>
<td>0.33</td>
<td>0.21</td>
<td>0.22</td>
<td>0.23</td>
<td>0.25</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td>Sum</td>
<td>0.46</td>
<td>0.28</td>
<td>0.31</td>
<td>0.31</td>
<td>0.40</td>
<td>0.45</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Average execution time of the test cases using templates.
Conclusion and Future Work

» Introduced filmstrip templates and proposed different filmstrip architectures

» Study revealed that employing filmstrip templates are more efficient in terms of execution time

» Architecture B, C and D yield better results compared to others

» Future work:
  » Development and implementation of automatic generation of the filmstrip templates
  » Distinguishing application and filmstrip elements in the configuration and user interface
Thanks for your attention!

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